

# Helping Science Succeed

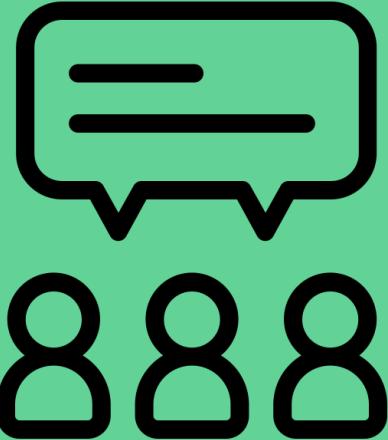
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The Librarian's Role in Addressing the Reproducibility Crisis

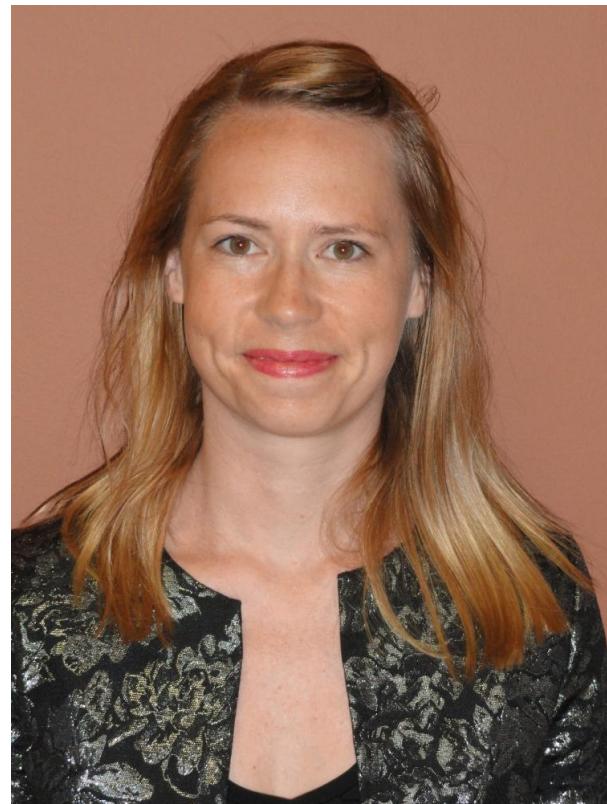
Franklin Sayre  
Amy Riegelman

#MLAReproducibility  
[osf.io/n8dv2/](https://osf.io/n8dv2/)

Discussion: In the chat share what you are hoping to gain from this webinar.



Created by Bharat  
from Noun Project



# Agenda

1. Definitions & History
2. The Packaging of Science & the Librarian's Role
- 3. Break**
4. Case Studies
5. Developing an Action Plan



# The Reproducibility Crisis and Academic Libraries

In recent years, evidence has emerged from disciplines ranging from biology to economics that many scientific studies are not reproducible. This evidence has led to declarations in both the scientific and lay press that science is experiencing a “reproducibility crisis” and that this crisis has significant impacts on both science and society, including misdirected effort, funding, and policy implemented on the basis of irreproducible research. In many cases, academic libraries are the natural organizations to lead efforts to implement recommendations from journals, funders, and societies to improve research reproducibility. In this editorial, we introduce the reproducibility crisis, define reproducibility and replicability, and then discusses how academic libraries can lead institutional support for reproducible research.

## *College & Research Libraries* in January 2018

## *College & Research Libraries* in March 2019

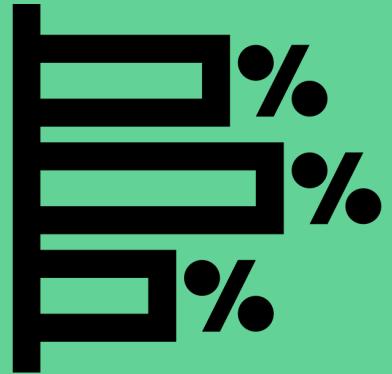
### **Replicable Services for Reproducible Research: A Model for Academic Libraries**

Franklin Sayre, Amy Riegelman

#### **Abstract**

Over the past decade evidence from disciplines ranging from biology to economics has suggested that many scientific studies may not be reproducible. This has led to declarations in both the scientific and lay press that science is experiencing a “reproducibility crisis” and that this crisis has consequences for the extent to which students, faculty, and the public at large can trust research. Faculty build on these results with their own research, and students and the public use these results for everything from patient care to public policy. In order to build a model for how academic libraries can support reproducible research the authors conducted a review of major guidelines from funders, publishers, and professional societies. Specific recommendations were extracted from guidelines and compared with existing academic library services and librarian expertise. The authors believe this review shows that many of the recommendations for improving reproducibility are core areas of academic librarianship, including data management, scholarly communication, and methodological support for systematic reviews and data-intensive research. By increasing our knowledge of disciplinary, journal, funder, and society perspectives on reproducibility, and reframing existing librarian expertise and services, academic librarians will be well positioned to be leaders in supporting reproducible research.

Poll: How  
comfortable are you  
**supporting** research  
reproducibility?



Created by b\_farias  
from Noun Project

# Definitions & History of a Crisis

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Introduction

Definitions  
& History

Packaging of  
Science

Case Studies

Action Plan

# DEFINITIONS: REPRODUCIBILITY

*"the ability of a researcher to duplicate the results of a prior study using the same materials and procedures as were used by the original investigator."*

Bollen, K., Cacioppo, J., Kaplan, R., Krosnick, J. A., & Olds, J. L. (2015). Social, Behavioral, and Economic Sciences Perspectives on Robust and Reliable Science. Report of the Subcommittee on Replicability in Science Advisory Committee to the National Science Foundation Directorate for Social, Behavioral, and Economic Sciences.

# DEFINITIONS: REPLICABILITY

*“the ability of a researcher to duplicate the results of a prior study if the same procedures are followed but new data are collected.”*

Bollen, K., Cacioppo, J., Kaplan, R., Krosnick, J. A., & Olds, J. L. (2015). Social, Behavioral, and Economic Sciences Perspectives on Robust and Reliable Science. Report of the Subcommittee on Replicability in Science Advisory Committee to the National Science Foundation Directorate for Social, Behavioral, and Economic Sciences.

# Reproducible Research Spectrum

(Stodden, et al., 2014)

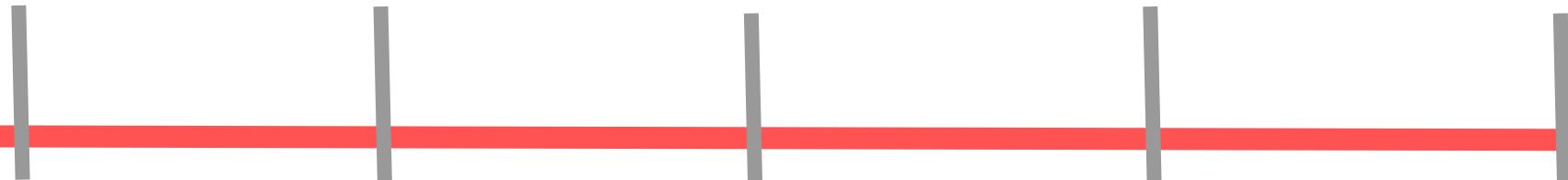
The descriptions of the research methods can be independently assessed and the results judged credible (Does not necessarily imply reproducibility.)

**Reviewable**

Replicable

Confirmable

**Open or  
Auditable      Reproducible**



Well-documented and fully open code and data allowing others to (a) fully audit the computational procedure, (b) replicate and also independently reproduce the results of the research, and (c) extend the results or apply the method to new problems.

# Landmark reproducibility research

- Why Most Published Research Findings Are False by John Ioannidis (2005)
- Reproducibility Project: Psychology (2012-2015)
- Reproducibility Project: Cancer Biology (2013 - 2018)
- 1,500 scientists lift the lid on reproducibility (Nature Survey, 2016)



The Meaning of  
“Significance”  
for Different  
Types of  
Research by de  
Groot

Statistical  
Power  
Analysis for  
the  
Behavioral  
Sciences by  
Cohen

Consequences  
of Prejudice  
Against the  
Null  
Hypothesis by  
Greenwald

The File  
Drawer  
Problem  
and  
Tolerance  
for Null  
Results by  
Rosenthal

Why Most  
Published  
Research  
Findings  
Are False

RP: P  
RP: CB

1950s

1960s

1970s

2000s

2010s

# Nefarious Behavior v. Honest Errors

The Mind of a Con Man



(Bhattacharjee, 2013)

# Range of behavior, action, inaction

Range of behaviors from intentional, nefarious to naive or unaware

Egregious,  
fraudulent

Unaware of  
study flaws

# Questionable Research Practices (QRPs)

- p-Hacking
- HARKing
- Underpowered studies
- Bias against null



# p-Hacking

Data Dredging  
Data Fishing

---

# HARK: Hypothesizing After Results are Known

"HARKing is defined as presenting a post hoc hypothesis (i.e., one based on or informed by one's results) in one's research report as if it were, in fact, an a priori hypotheses."  
(Kerr, 1998)

---

# Underpowered Studies

Low statistical power

False positives

Unreliable results

Erroneous conclusions

---

Amy Cuddy | TEDGlobal 2012

## Your body language may shape who you are



Carney, D. R., Cuddy,  
A. J., & Yap, A. J.  
(2010). Power posing:  
Brief nonverbal  
displays affect  
neuroendocrine  
levels and risk  
tolerance.  
*Psychological  
Science*, 21(10),  
1363-1368.

n = 42

# Bias Against Null

Leads to “file drawer problem”

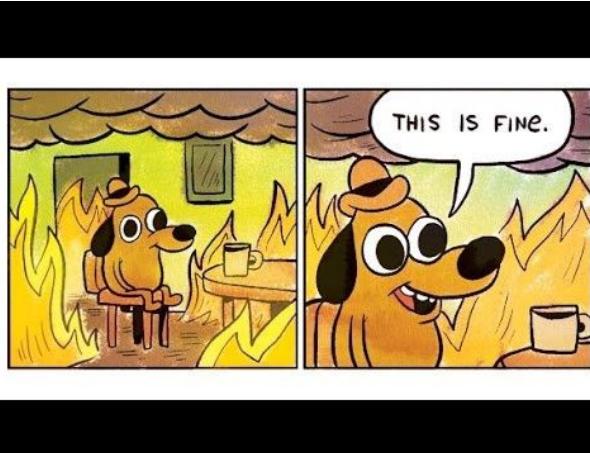
Publication bias

“By chance” research favored

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# Is it a Crisis?

The status quo is broken.  
Significant changes  
needed.



Science is self correcting.  
No changes necessary.



# Politicized language

- "Crisis" language used in popular press, public & government entities
- Reproducibility issues have "been politicalized by actors and groups looking to undermine science and evidence based policy."

(Kubas, Riegelman, & Sayre, 2018)

## FEATURE

### **US Government Resources Related to Research Rigor and Reproducibility**

Alicia Kubas, Amy Riegelman, and Franklin Sayre, University of Minnesota

The reproducibility of scientific studies has recently come under increased scrutiny in both the popular and scientific press.<sup>1</sup> Studies from various disciplines (e.g., psychology, health sciences) have revealed failures to reproduce and repli-

data and data sharing requirements, finding repos registering studies and analysis, and finding disc guidelines for what to report in a research publi mote transparency and reproducibility. A call for

# Open ≠ Reproducible

Research article

## Data availability, reusability, and analytic reproducibility: evaluating the impact of a mandatory open data policy at the journal *Cognition*

Tom E. Hardwicke, Maya B. Mathur, Kyle MacDonald, Gustav Nilsonne, George C. Banks, Mallory C. Kidwell, Alicia Hofelich Mohr, Elizabeth Clayton, Erica J. Yoon, Michael Henry Tessler, Richie L. Lenne, Sara Altman, Bria Long, and Michael C. Frank

Published: 01 August 2018 | <https://doi.org/10.1098/rsos.180448>

### Abstract

Access to data is a critical feature of an efficient, progressive and ultimately self-correcting scientific ecosystem. But the extent to which in-principle benefits of data sharing are realized in practice is unclear. Crucially, it is largely unknown whether published findings can be reproduced by repeating reported analyses upon shared data ('analytic reproducibility'). To investigate this, we conducted an observational evaluation of a mandatory open data policy introduced at the journal *Cognition*. Interrupted time-series analyses indicated a substantial post-policy increase in data available statements (104/417, 25% pre-policy to 136/174, 78% post-policy), although not all data appeared reusable (23/104, 22% pre-policy to 85/136, 62%, post-policy). For 35 of the articles determined to have reusable data, we attempted to reproduce 1324 target values. Ultimately, 64 values could not be reproduced within a 10% margin of error. For 22 articles all target values were reproduced, but 11 of these required author assistance. For 13 articles at least one value could not be reproduced despite author assistance. Importantly, there were no clear indications that original conclusions were seriously impacted. Mandatory open data policies can increase the frequency and quality of data sharing. However, suboptimal data curation, unclear analysis specification and reporting errors can impede analytic reproducibility, undermining the utility of data sharing and the credibility of scientific findings.

# The Packaging of Science: Reproducibility Guidelines & The Librarian's Role

Introduction

Definitions  
& History

Packaging of  
Science

Case Studies

Action Plan

*“First, a finding needs to be repeatable to count as a scientific discovery. Second, research needs to be reported in such a manner that others can reproduce the procedures.”*

(Zwaan, Etz, Lucas, & Donnellan, 2018)

# The Content of Science

- Hypothesis
- Study Design
- Analysis

# The Reporting (Packaging) of Science

- Was the research published?
  - Were methods adequately reported?
  - Was the analysis plan transparent?
  - Was the code, data, & materials transparent?
  - Is the published article accessible?
  - Is the published article discoverable?
  - Do incentives align?
-

# Reproducibility Guidelines

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# Major Guidelines

- Transparency and Openness Promotion (TOP)
- American Statistical Association “Recommendations to Funding Agencies for Supporting Reproducible Research”
- NIH Rigor & Reproducibility Guidelines

# Transparency & Openness Promotion (TOP) Guidelines

8 standards at 3 possible tiers:

1. **DISCLOSURE:** The article must disclose whether or not materials are available
2. **REQUIREMENT:** The article must share materials when possible.
3. **VERIFICATION:** Third party must verify that the standard is being met.

# TOP: Standards

- **Standard 1: Proper Citation of:** data, code, and materials.

## *Level 1*

All data, program code and other methods should be appropriately cited. Such materials should be recognized as original intellectual contributions and afforded recognition through citation.

- All data sets and program code used in a publication should be cited in the text and listed in the reference section.
- References for data sets and program code should include a persistent identifier, such as a Digital Object Identifier (DOI). Persistent identifiers ensure future access to unique published digital objects, such as a text or data set. Persistent identifiers are assigned to data sets by digital archives, such as institutional repositories and partners in the Data Preservation Alliance for the Social Sciences (Data-PASS).
- *Data set citation example:* Campbell, Angus, and Robert L. Kahn. American National Election Study, 1948. ICPSR07218-v3. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor], 1999. <http://doi.org/10.3886/ICPSR07218.v3>

## TOP: Standards

- Standard 2, 3, 4: *Data Transparency, Analytic Methods (code) Transparency, Research Materials Transparency*: Sharing of underlying data, analytical code, and research materials.

# TOP: Transparency & Openness Promotion

- **Standard 5 Design and analysis transparency:** Authors must follow explicit guidelines for disclosing key aspects of research design and analysis.
- **Standard 6, 7: Preregistration:** of studies and analysis plans.
- **Standard 8: Replication:** This standard relates to the journal's willingness to publish direct replications of studies it previously published.

# ASA: Recommendations to Funding Agencies for Supporting Reproducible Research Guidelines

- Principles and Observations
- Funding small-scale software development, data products, and replications of previous studies.
- Increasing support for the methodological training, with particular emphasis on the need for data management skills.
- Adding code management plans to existing Data Management Plans (DMPs) and asking grant reviewers to explicitly assess DMPs.
- Creating mandatory undergraduate reproducibility and computational research classes.

# NIH Rigor & Reproducibility Guidelines

- Rigorous Statistical Analysis
- Transparency in Reporting
- Data and Materials Sharing
- Consideration of Refutations
- Follow best methodological guidelines (antibodies, cell lines, animals)
- Adapt other guidelines (including TOP)

# Disciplinary Guidelines: Examples



SOCIETY *for*  
NEUROSCIENCE

*Research Practices for Scientific  
Rigor: A Resource for Discussion,  
Training, and Practice*

## Enhancing Research Reproducibility:

Recommendations from the  
Federation of American Societies for Experimental Biology

# Disciplinary Guidelines: Reproducibility Bibliography

## Reproducibility Bibliography

Reproducibility Guidelines and Disciplinary Examples

Home About Guidelines Examples Other

## All Guidelines

Zwaan, R., & Eerland, A. (2018). To Have Practical Relevance, Scientific Claims Need to be Accurate [preprint]. <https://doi.org/10.17605/OSF.IO/KQES9>

Toelch, U., & Ostwald, D. (2018). Digital open science—Teaching digital tools for reproducible and transparent research. *PLOS Biology*, 16(7), e2006022. <https://doi.org/10.1371/journal.pbio.2006022>

The National Science Foundation, & The Institute of Education Sciences. (2018, November 28). Companion Guidelines on Replication & Reproducibility in Education Research: A Supplement to the Common Guidelines for Education Research and Development. Retrieved from <https://ies.ed.gov/pdf/CompanionGuidelinesReplicationReproducibility.pdf>

Stodden, V., Seiler, J., & Ma, Z. (2018). An empirical analysis of journal policy effectiveness for computational reproducibility. *Proceedings of the National Academy of Sciences*, 115(11), 2584–2589. <https://doi.org/10.1073/pnas.1708290115>

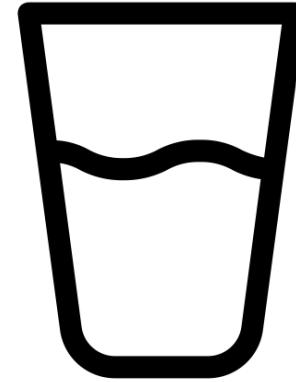
Smith, A. T., Clinton, D. E., Gillow, F., Hancock, K. P. A., & Penttilä, M. (2018). PREPARE: guidelines for

<https://reproducibility.dash.umn.edu/>

**TABLE 1**  
**Commonalities Between Major Reproducibility Guidelines**

	<b>Transparency and Openness Promotion (TOP)</b>	<b>American Statistical Association (ASA)</b>	<b>National Science Foundation (NSF)</b>	<b>National Institute of Health (NIH)</b>
<b>Data Transparency (Sharing)</b>	Yes	Yes (+ assessment of DMPs by funders)	Yes	Yes
<b>Software Transparency (Sharing)</b>	Yes	Yes	Yes	Yes
<b>Materials Transparency (Sharing)</b>	Yes			Yes
<b>Methods Transparency</b>	Yes		Yes	Yes
<b>Preregistration</b>	Yes (study + analysis plans)			
<b>Supporting Replications</b>	Yes	Yes (directly fund)	Yes (+ publishing negative results)	Yes
<b>Best Practices for Methodology and Analysis</b>		Computational methods / Scripting analysis		

# Break



Please add questions to chat

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from Noun Project

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# **Library Services and Expertise that Address Reproducibility**



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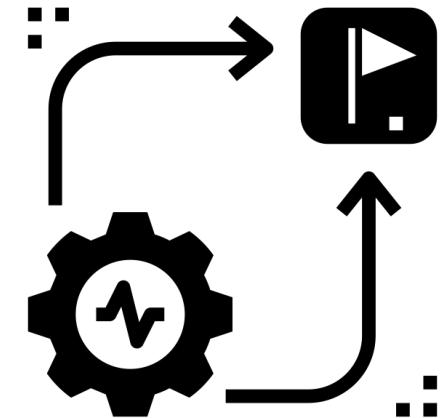
Action Plan

# Themes

- Methods
- Reporting and Dissemination
- Transparency and Open Science
- Evaluation
- Incentives

# Methods

- Connector to methodological and statistical support units
- Support for systematic reviews
- Support for data-intensive research methodologies
- Supporting computational reproducibility



Created by Nithinan Tatah  
from Noun Project

# Reporting and Dissemination: Supporting Computational Methods

“I should be able to sneak into your lab late at night, delete everything except for your raw data and your code, and you should be able to run a single command to regenerate EVERYTHING, including all of your results, tables, and figures in their final, polished form”

Justin Kitzes - [Reproducible Workflows](#)



# Reporting and Dissemination

- Open Access publisher
- Encouraging Replications
- Finding and using Reporting Guidelines
- Supporting Pre-registrations



Created by Adrien Coquet  
from Noun Project

# Finding and Using Guidelines

## Reporting guidelines

- PRISMA and others indexed on [Equator Network](#)



Enhancing the QUAlity and Transparency Of health Research

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find reporting guidelines | improve your writing | join our courses | run your own training course | enhance yo



### Library for health research reporting

The Library contains a comprehensive searchable database of reporting guidelines and also links to other resources relevant to research reporting.



Search for reporting guidelines



Not sure which reporting guideline to use?



Reporting guidelines under development



Visit the library for more resources



### Reporting guidelines for main study types

[Randomised trials](#)

[CONSORT](#) [Extensions](#)

[Observational studies](#)

[STROBE](#) [Extensions](#)

[Systematic reviews](#)

[PRISMA](#) [Extensions](#)

[Study protocols](#)

[SPIRIT](#) [PRISMA-P](#)

[Diagnostic/prognostic studies](#)

[STARD](#) [TRIPOD](#)

[Case reports](#)

[CARE](#) [Extensions](#)

[Clinical practice guidelines](#)

[AGREE](#) [RIGHT](#)

[Qualitative research](#)

[SRQR](#) [COREQ](#)

[Animal pre-clinical studies](#)

[ARRIVE](#)

[Quality improvement studies](#)

[SQUIRE](#)

[Economic evaluations](#)

[CHEERS](#)

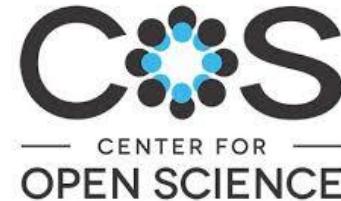
# Reporting and Dissemination: Pre-Registration

## Pre-Registration

stating your research plan before gathering data.

Exploratory vs Confirmatory

Hypothesis testing vs. Hypothesis generating



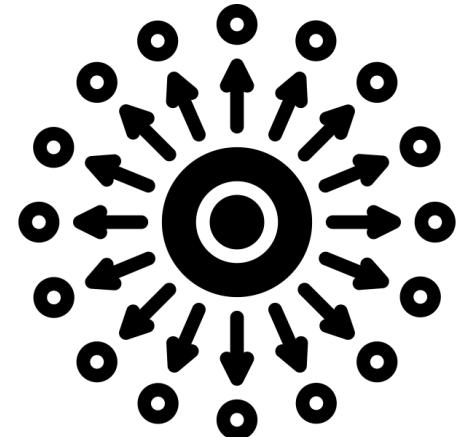
## PROSPERO

International prospective register of systematic reviews



# Transparency and Open Science

- Data curation
- Supporting Data/Code/Methods Sharing
- Active Research Data Management

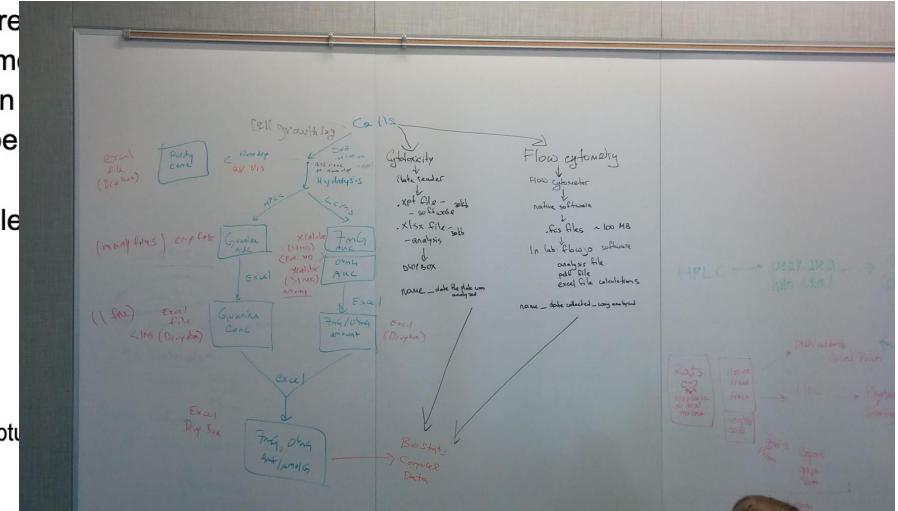


Created by priyanka  
from Noun Project

# Transparency & Open Science: Active Data Lab Management

## Your Data: File Naming / Directory Structures

- Where are files being generated and stored? (mark on flow-chart)
  - How are the files organized?
    - How are you naming these files?
    - What is the directory?
    - Do the file names make sense?
  - what needs to be included?
    - **Prompts:** experiment, experimenter
  - Where are these files stored (next section)

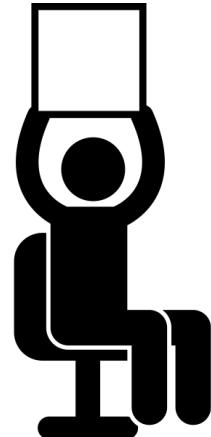


## Draw workflow

- Draw flowchart vertically
  - Put the purpose of process at top (cytotoxicity, DNA etc)
  - Use the following shapes:
    - Circle: Input/Sources (e.g. cell lines, animals, samples)
    - Triangle: Instrument or process (includes software)
    - Box: Output/Files
  - Connect shapes with arrows
  - Consider annotating the flow chart with some of the following:
    - Where are the data/reagent/etc stored?
    - Who has access to the files, equipment, etc.?
    - How and where are you documenting what's being done?
    - What type of files are you creating and how much data is being generated and captured?
    - Anything else you feel is important about your data or workflow
  - Do the file names make sense?
    - what needs to be included?
    - **Prompts:** experiment, sample, time point, etc.
  - Where are these files stored (next section)

# Evaluation (Diversifying Peer Review)

- Registered Reports
- Supporting Preprints



Created by Gan Khoon Lay  
from Noun Project

# Evaluation: Registered Reports

**Registered Reports.** Registered Reports are a submission format in which manuscripts are reviewed prior to data collection and/or analysis. Authors submit only the Introduction, Method, and Analysis Plan sections of their manuscript for review (as well references, relevant tables, etc.). This “Stage 1 Proposal” is reviewed and subsequently rejected or revised just like any other manuscript. The review process focuses primarily on:

- The significance of the research question(s)
- The logic, rationale, and plausibility of the proposed hypotheses
- The soundness and feasibility of the methodology and analysis pipeline (including statistical power analysis)
- Whether the clarity and degree of methodological detail would be sufficient to replicate exactly the proposed procedures and analysis pipeline
- Whether the authors provide a sufficiently clear and detailed description of the methods to prevent undisclosed flexibility in the experimental procedures or analysis pipeline

## Registered Reports

studies reviewed before data collection and analysis. Editors review submissions rejecting, etc.

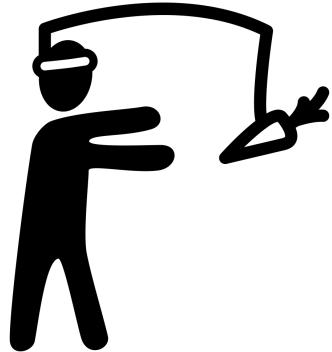
# Supporting Preprints

- “Complete and public draft of a scientific document... Preprints are typically unreviewed manuscripts written in the style of a peer-reviewed journal article” (NIH, 2017)
- Purposes:
  - to speed dissemination
  - establish priority
  - obtain feedback
  - offset publication bias.
- Categorized as Grey Literature

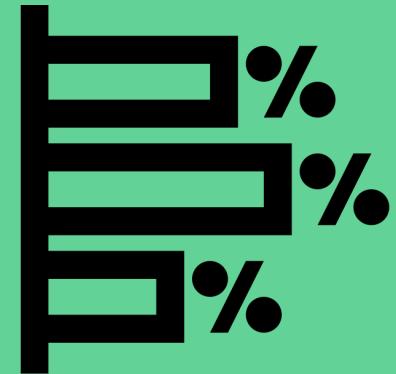


# Incentives (Rewarding Open and Reproducible Practices)

- Rewarding Open and Reproducible Practices
- Citation standards
- Education about the impact of citation metrics
- Citation data provider to Tenure and Promotion (T&P) Committees



# Poll: What services do you or your library already support?



Created by b\_farias  
from Noun Project

# Case Studies: Libraries Supporting Reproducibility

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# University of Utah



UNIVERSITY OF UTAH  
**SPENCER S. ECCLES  
HEALTH SCIENCES LIBRARY**

- 2016 - Research Reproducibility Conference
- 2017 - Grand Rounds Research Reproducibility
- 2017 - Research Reproducibility Coalition
- 2018 - Second Research Reproducibility Conference
- 2018 - Reproducibility Short Course
- Ongoing
  - Training Program
  - Reproducibility Coalition
  - Other courses and consultations

Melissa Rethlefsen & Tisha Mentnech



# New York University



NEW YORK UNIVERSITY

- Vicky Steeves: Research Data Management and Reproducibility Librarian
- Reproducibility Symposium at NYU (2016)
- LITA class: Building Services Around Reproducibility & Open Scholarship (2017)
- ReproZip
- Reproducibility Resource Directory
- LIS Scholarship Archive (LISSA)



- Initiating discussions with other librarians
- Presentations to faculty, research groups, departments
- Reproducibility lightning talks
- Many Faces of Reproducibility
- NIH Training Grant
- Ongoing staff contributions (e.g., curation) to DRUM, UMN's data repository
- StudySwap

- Director change
- 2019 - Reproducibility Librarian position posted
- 2019 - Teaching Rigor & Reproducibility component of College of Medicine's Responsible Conduct of Research course



# Developing an Action Plan to engage campus leadership and begin supporting reproducibility

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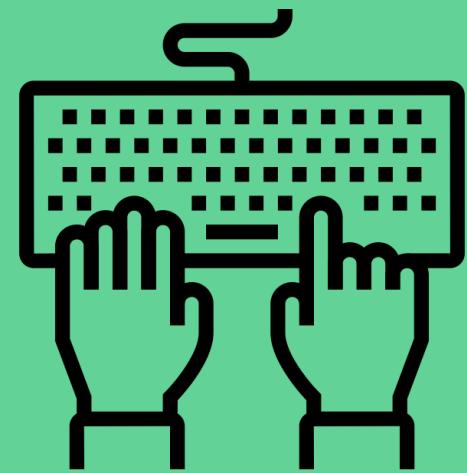
Action Plan

# Create an Action Plan

[z.umn.edu/reproducible](http://z.umn.edu/reproducible)



# Action Plan: Campus/Institutional Stakeholders

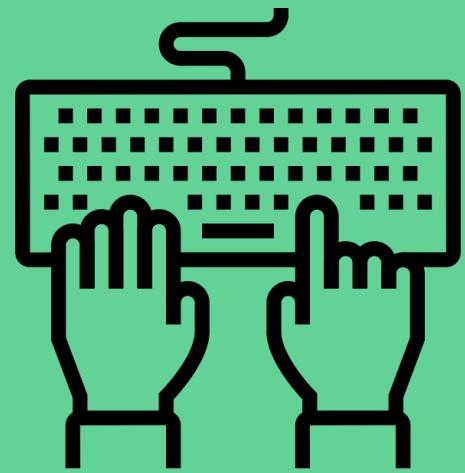


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# **Results from previous poll on existing services**



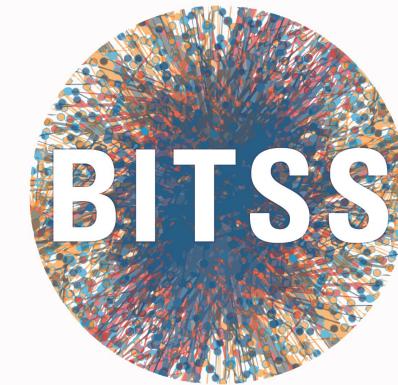
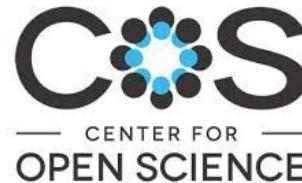
# Action Plan: Identifying Support Opportunities



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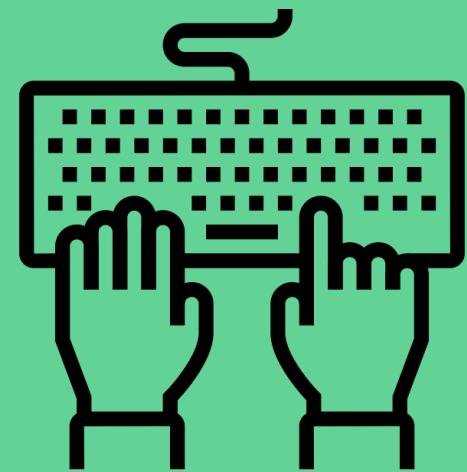
# Staying informed

- Conferences
- Institutes
- Scholarly literature (See [Reproducibility Bibliography](#))
- Reading groups / Journal clubs



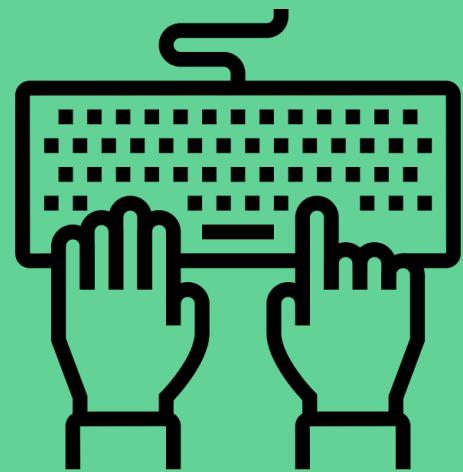
BERKELEY INITIATIVE FOR TRANSPARENCY  
IN THE SOCIAL SCIENCES

# Action Plan / Discuss: Staying Informed on Reproducibility



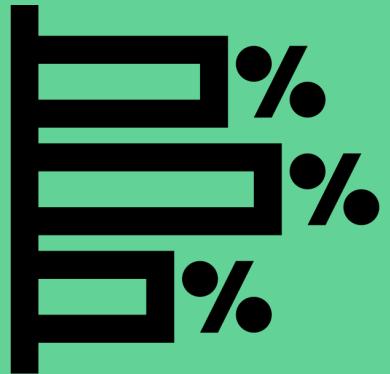
Created by Maxim Basinski  
from Noun Project

# Action Plan: Do you want a gentle nudge?



Created by Maxim Basinski  
from Noun Project

Poll: How  
comfortable are you  
**supporting** research  
reproducibility



Created by b\_farias  
from Noun Project

**Thank You!**

**Questions?**

# Resources

Baker, M. 1,500 scientists lift the lid on reproducibility. *Nature News*.

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